

Office of Food Safety and Shellfish Programs
2002 Annual Inventory:

Commercial & Recreational Shellfish
Areas of Washington State

June 2003



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2002 Annual Inventory:**

**Commercial & Recreational Shellfish Areas
of Washington State**

June 2003



The Department of Health works to improve and protect the health of people in Washington State

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INTRODUCTION

This is the fourteenth edition of the *Annual Inventory of Commercial and Recreational Shellfish Areas of Washington State*. Formerly titled the *Annual Inventory of Commercial and Recreational Shellfish Areas of Puget Sound*, the name was amended last year to more accurately reflect the scope of this document, which includes Washington's coastal waters as well as those of the Puget Sound.

This publication is produced by the Washington State Department of Health, Office of Food Safety and Shellfish Programs (DOH). It provides important health information about shellfish resources in Washington's marine waters and contributes to the fulfillment of the Puget Sound Water Quality Management Plan.

The Puget Sound Water Quality Management Plan, administered by the Puget Sound Water Quality Action Team, is the state's strategy for protecting Puget Sound's health — its water quality and its biological resources. DOH participates with many other agencies to carry out the plan.

Included with this publication is a poster-size map of the state's shellfish growing areas. The map includes features such as commercial growing area classifications, major streams, sewage treatment plant outfalls, and recreational shellfish beach classifications. Comments or suggestions are welcome for future editions. Map information is available in electronic GIS format.

Please contact Jan Jacobs at (360) 236-3316 with any comments or requests for this publication. An electronic copy of this publication can be found on the Internet at www.doh.wa.gov/ehp/sf/pubs.

DEFINITIONS AND PROCESS FOR CLASSIFYING COMMERCIAL SHELLFISH GROWING AREAS

DOH classifies all commercial shellfish growing areas in Washington State as Approved, Conditionally Approved, Restricted, or Prohibited. These classifications have specific standards associated with them, which are derived from the *National Shellfish Sanitation Program Model Ordinance* (Chapter IV, 1999 Revision).

Definitions

Approved Areas

This classification authorizes the growing and harvesting of shellfish for direct marketing. DOH may classify a growing area as Approved when pollution source evaluations and the bacteriological water quality data show that fecal material, pathogenic microorganisms, and poisonous or deleterious substances are not present in dangerous concentrations.

The bacteriological quality of marine water samples collected from an Approved growing area must satisfy both parts of the following standard:

- 1) The concentration of fecal coliform bacteria, the indicator organisms, shall not exceed a geometric mean of 14 per 100 milliliters (ml); and
- 2) The estimated 90th percentile cannot exceed 43 organisms per 100 ml if sampling under the systematic random

scheme. If sampling where point sources of pollution may impact the growing area, not more than 10 percent of the samples can exceed 43 organisms per 100 ml.

A minimum of 30 samples is used for these calculations with the laboratory using the A-1 modified, 5-tube/3-dilution method to estimate the most probable number of fecal coliform bacteria.

Even if the Approved criteria are met for fecal coliform bacteria, DOH may classify a growing area as Conditionally Approved, Restricted, or Prohibited (see definitions below) if pollution source investigations show that contamination may impact the sanitary condition of shellfish in the area. Because fecal coliform bacteria are not always good indicators of the presence of disease-causing viruses and other pathogens, DOH depends on thorough evaluations of pollution sources. DOH temporarily closes Approved shellfish growing areas when events such as floods or biotoxin blooms occur.

Conditionally Approved

A growing area that meets Approved criteria only during predictable periods may be classified as Conditionally Approved. For example, in some growing areas DOH has been able to show that Approved criteria are met except for several days following a particular amount of rainfall. DOH manages the area by closing it for a specified time period following that quantity of rainfall.

Restricted

If the bacteriological water quality of a commercial growing area does not meet the standard for an Approved classification, but the sanitary survey indicates only a limited degree of pollution, the area may be classified as Restricted. Shellfish harvested from Restricted growing areas cannot be marketed directly, but must be "relayed" to an Approved growing area where they will naturally purge themselves of contaminants. The cleansing period required is generally a few weeks to several months. Restricted classifications are only considered where levels of pollution are low and relay times are shown to purify the shellfish prior to marketing.

Prohibited

A growing area must be classified as Prohibited when information indicates that fecal material, pathogenic microorganisms, or poisonous or deleterious substances may be present in dangerous concentrations. Marine waters adjacent to sewage treatment plant outfalls, marinas, and other persistent or unpredictable pollution sources must be classified as Prohibited. *Commercial harvests of shellfish are not allowed from Prohibited areas.*

Under the National Shellfish Sanitation Program, if DOH has not conducted a sanitary survey, it must classify the growing areas as Prohibited.

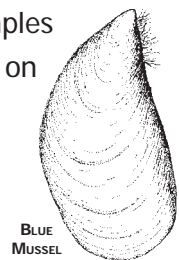
Process

The commercial growing area classification process is called a "sanitary survey" and consists of three parts. These are:

- 1) The "shoreline survey," an investigation of point and nonpoint pollution sources that may impact shellfish sanitation;
- 2) The "marine water quality evaluation," an analysis of the bacterial water quality in the marine water; and
- 3) The "meteorological and hydrographic evaluation," an analysis of meteorological and hydrographic factors that may affect the distribution of pollutants in the area.

The purpose of the pollution source surveys and water quality studies are to ensure that the area complies with the standards associated with its classification, to modify the classification when needed, and to notify the responsible agencies about identified contamination sources. Monitoring data and reports resulting from these studies are transmitted to local governments and the Department of Ecology. These reports are available to interested parties upon request. For more information on the classification process, contact Bob Woolrich at (360) 236-3329.

In addition to water quality monitoring and shoreline surveys, paralytic shellfish poisoning and domoic acid samples are collected in classified areas on a routine basis. (See Marine Biotoxin Monitoring Program, page 22.)



Shoreline Survey

The shoreline survey component of the sanitary survey consists of the periodic evaluation of all point and nonpoint contamination sources located where they have the potential to impact a growing area. Sources are identified and evaluated through field surveys conducted by DOH in cooperation with local health departments, Tribes, and the Department of Ecology. Emphasis is placed on general shoreline activity, on-site sewage systems, animal farms, drainage ways, and wildlife activity. Pollution sources needing corrections are referred to the appropriate pollution control agencies for action. DOH also evaluates the actual and potential impacts of point sources, and establishes closure zones around wastewater treatment plants and marinas.

During 2002, DOH completed shoreline surveys within 4 classified commercial growing areas and 5 proposed growing areas. In addition, 6 surveys were completed along portions of classified growing areas to obtain additional information regarding potential upland sources of pollution. The completed surveys encompassed 142 marine shoreline miles, 1,041 shoreline parcels and 513 drainage/discharge points. Figure 1 lists the areas, shoreline miles, parcels and drainage/discharge points evaluated. For more

information regarding shoreline surveys, or to request a copy of a shoreline survey report, contact Scott Berbell at (360) 236-3324.



SOFTSHELL
CLAM

Marine Water Quality

Marine water samples are collected to measure the concentration of fecal coliform bacteria in the growing waters. The concentration of fecal coliform bacteria can indicate the presence of pathogens that transmit hepatitis, salmonella, and other diseases to humans. DOH conducts water quality sampling throughout the year in all active commercial shellfish growing areas.

In 2002, DOH collected over 10,000 marine water quality samples from approximately 1,400 sampling stations. For more information regarding marine water quality sampling and station locations contact Jerry Lukes at (360) 236-3319.

Meteorological and Hydrographic Factors

Meteorological and hydrographic information is used by DOH to determine the extent and impact from a known pollution source on a shellfish growing area. This information is obtained from other agencies as well as from studies done by DOH, and is described in more detail in the Closure Zone Determination section on page 16. For more information regarding meteorological and hydrographic factors contact Frank Meriwether at (360) 236-3321.

STATUS OF COMMERCIAL SHELLFISH GROWING AREAS

In 2002, DOH classified 90 commercial harvest areas in the state, covering over 200,000 acres. Many of the classified harvest

areas had multiple classifications. For example, in the area called Nisqually Reach, DOH classified portions as Approved, Restricted, and Prohibited.

In 2002 we had 84 growing areas with Approved classifications, 12 with Conditionally Approved classifications, and 8 with Restricted classifications.

DOH closed the 12 Conditionally Approved areas under the following types of predictable pollution circumstances:

- Rainfall closures;
- Sewage treatment plant upsets; and
- Seasonal closures due to marinas.

Figure 2 lists the Conditionally Approved areas managed by rainfall.

Since 1981, DOH has downgraded the classification of about 47,000 acres as the result of declines in sanitary conditions, but has upgraded only about 18,000 acres. In the 1980s, DOH downgraded the classification of almost 33,000 acres, but upgraded only about 1,000 acres. However, since 1990 the total acres upgraded and downgraded were nearly equal. These classification changes are shown in Figure 3.

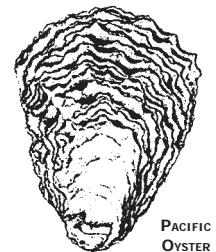
In 2002, DOH reclassified four growing areas. North Bay and parts of Grays Harbor, Samish Bay, and Nisqually Reach were upgraded. Figure 4 shows the reclassifications of intertidal shellfish growing areas done in 2002.

Threatened Shellfish Growing Areas

Each year DOH reviews the classification and develops an annual report for each of our shellfish growing areas. During this process, we identify those shellfish growing areas that marginally meet their classification. We consider these areas to be “threatened with downgrades” and we put them on an “early warning list.” We then notify stakeholders and issue a press release about the threatened areas.

The list and the reports are sent to the Pacific Coast Shellfish Growers Association, the Northwest Indian Fisheries Commission, the Puget Sound Action Team, and the Department of Ecology. In addition, we send reports to the local health departments and send individual growing area reports to shellfish growers who harvest in threatened areas. The objective is to correct pollution problems before we have to close an area or downgrade its classification.

Downgrades in classification are bad news. They restrict or eliminate commercial harvesting of shellfish; they close public shellfish beaches to recreational shellfish harvesters; and they indicate that pollution is getting worse. Downgrades also require a reaction. When an area is downgraded due to nonpoint pollution, state law requires local governments to form shellfish protection districts to address the problem.



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continued on page 12

Figure 1. Shoreline Surveys Completed in 2002

Area	Marine Shoreline Miles	Parcels Evaluated	Drainages / Discharges Evaluated
Bruceport (addendum)	2	0	1
Dabob Bay	25	37	33
Drayton Passage Tracts 13100 & 13200	6	34	2
Dyes Inlet E. Erlands Point	1	47	1
Hood Canal 1	33	309	188
Hood Canal 2 (addendum)	2	28	9
Hood Canal 5	24	216	122
Hood Canal 6 (addendum)	6	143	41
Mackaye Harbor (addendum)	1	3	0
Mats Mats Bay	3	46	27
McNeil Island (addendum)	12	7	24
Penrose Point State Park	5	46	33
Pickering Passage (addendum)	3	34	9
Samish Bay	16	10	14
Stretch Island	3	81	9

Figure 2. 2002 Rainfall Closures in Conditionally Approved Areas

Area	Closure Criteria	Closure Length	No. of Closures	Days Closed
Filucy Bay	≥0.5" rainfall / 24 hr.	6 days	19	75
Grays Harbor *	≥1.0" rainfall / 24 hr. or STP upset	7 days	10	59
Henderson Inlet	≥0.5" rainfall / 24 hr.	5 days	20	72
Nisqually Reach *	≥1.0" rainfall / 24 hr.	5 days	5	21
North Bay *	≥0.5" rainfall / 24 hr.	5 days	18	60
Oakland Bay	≥1.0" rainfall / 24 hr.	5 days	11	43
South Skagit Bay	≥0.5" rainfall / 24 hr.	5 days	8	32

* Rainfall closure condition no longer in effect

Figure 3. Commercial Shellfish Growing Area Reclassifications Since 1981

Growing Area	Classification Downgrades				Classification Upgrades			
	Year	Change	Acres	Reason	Year	Change	Acres	Reason
Bay Center (Pacific Co.)	11/89	Approved to Prohibited	1,590	Rural nonpoint	9/92	Prohibited to Conditionally Approved	1,030	Improvement in shoreline conditions
					10/99	Conditionally Approved to Approved	340	Improved water quality results
					6/00	Conditionally Approved to Approved	690	Improved water quality results
Burley Lagoon (Pierce Co.)	1981	Approved to Restricted	210	Rural nonpoint	10/93	Restricted to Conditionally Approved	210	Correction of sewage system failures and agricultural waste problems
	1/99	Conditionally Approved to Restricted	210	Rural nonpoint	1/99	Prohibited to Restricted	20	Administrative change only
					5/01	Restricted to Approved	110	Correction of sewage system failures and agricultural waste problems
Chico Bay / Dyes Inlet (Kitsap Co.)					12/93	Prohibited to Restricted	150	Reevaluation of point sources
Dosewallips (Jeff. Co.)	9/87	Approved to Restricted	180	Marine mammals (seals)	4/94	Restricted to Approved	30	Seals access to shoreline area was restricted
Drayton Harbor (What. Co.)	1988	Approved to Prohibited	620	Rural nonpoint				
	1/95	Approved to Restricted	30	Point source and rural nonpoint				
	1/95	Approved to Prohibited	1,010	Point source and rural nonpoint				
	9/99	Approved to Prohibited	920	Various point and nonpoint pollution sources				

Figure 3 Continued. Commercial Shellfish Growing Area Reclassifications Since 1981

Growing Area	Classification Downgrades				Classification Upgrades			
	Year	Change	Acres	Reason	Year	Change	Acres	Reason
Duckabush (Jeff. Co.)	7/88	Approved to Restricted	630	Rural nonpoint	3/01	Restricted to Approved	630	Improved water quality
Dungeness Bay (Clallam County)	1/00	Approved to Prohibited	300	Area near mouth of river closed due to rural nonpoint pollution				
	4/01	Approved to Prohibited	100	Rural nonpoint pollution				
Eld Inlet (Thurs. Co.)	2/83	Approved to Conditionally Approved	690	Rural nonpoint	2/98	Conditionally Approved to Approved	450	Repair of on-site sewage systems and improved farm practices
Filucy Bay (Pierce Co.)	8/01	Conditionally Approved to Restricted	7	Rural nonpoint pollution				
Grays Harbor (Grays Harbor Co.)					11/94	Conditionally Approved to Approved	17,370	Not the result of changes in sanitary conditions, but rather a reevaluation of hydrography
					8/02	Conditionally Approved to Approved	479	Improved water quality results
Hammersley Inlet (Mason Co.)					6/92	Prohibited to Approved	200	Not the result of changes in sanitary conditions, but rather a reevaluation of sewage treatment plant discharge and water quality

Figure 3 Continued. Commercial Shellfish Growing Area Reclassifications Since 1981

Growing Area	Classification Downgrades				Classification Upgrades			
	Year	Change	Acres	Reason	Year	Change	Acres	Reason
Henderson Inlet (Thurs. Co.)	1984	Approved to Conditionally Approved	180	Nonpoint				
	1985	Conditionally Approved to Prohibited	120	Nonpoint				
	9/00	Conditionally Approved to Prohibited	8	Nonpoint				
	6/01	Approved to Conditionally Approved	300	Nonpoint				
Liberty Bay (Kitsap Co.)	5/91	Conditionally Approved to Restricted	260	Rural and urban nonpoint	4/94	Restricted to Approved	70 (Lemolo Area)	Correction of on-site sewage system failures and re-evaluation of hydrographics
Lilliwaup Bay (Mason Co.)	7/98	Approved to Prohibited	22	Area failed fecal coliform standard; wildlife most likely cause				
Lower Hood Canal (#9) (Mason Co.)	1987	Approved to Prohibited	630	Rural nonpoint	10/96	Restricted to Approved	530	Correction of on-site sewage system failures
	2/93	Approved to Prohibited	960	Rural nonpoint including on-site sewage system failures	5/98	Prohibited to Approved	400	Repairs of on-site sewage systems
Minter Bay (Pierce Co.)	1982	Approved to Prohibited	60	Rural nonpoint				
Nisqually Reach (Thurs. Co.)	6/92	Approved to Conditionally Approved	2,130	Rural nonpoint				
	9/00	Conditionally Approved to Restricted	74	Rural nonpoint	9/00	Conditionally Approved to Approved	20	Improved water quality results
					7/02	Conditionally Approved to Approved	960	Improvements in nonpoint pollution sources

Figure 3 Continued. Commercial Shellfish Growing Area Reclassifications Since 1981

Growing Area	Classification Downgrades				Classification Upgrades			
	Year	Change	Acres	Reason	Year	Change	Acres	Reason
North Bay (Mason Co.)	5/91	Approved to Prohibited	1,260	On-site sewage system failures	10/91	Prohibited to Conditionally Approved	450	Correction of on-site sewage system failures
					6/92	Prohibited to Conditionally Approved	710	Correction of on-site sewage system failures
					10/92	Prohibited to Restricted	100	Correction of on-site sewage system failures
					9/02	Conditionally Approved to Approved	1,110	Community sewer system developed
North River (Pacific Co.)					7/98	Prohibited to Approved	900	On-site systems discharging to Willapa River connected to sewer
Oakland Bay (Mason Co.)	2/87	Conditionally Approved to Restricted	1,380	Urban point and nonpoint	4/89	Restricted to Conditionally Approved	1,380	Improvement in water quality
Penn Cove (Island Co.)	1983	Conditionally Approved to Prohibited	500	Sewage treatment plant	1/95	Prohibited to Conditionally Approved	450	Sewage treatment plant and nonpoint source improvements
Port Gamble Bay (Kitsap Co.)	7/96	Approved to Prohibited	20	Rural nonpoint	3/99	Prohibited to Approved	20	Rural nonpoint sources corrected
Port Susan (Snoh. & Island Co.)	5/87	Approved to Restricted	11,900	Agricultural nonpoint/ sewage treatment plant				
Portage Bay (What. Co.)	8/97	Approved to Restricted	60	Rural nonpoint				
	9/99	Approved to Restricted	90	Rural nonpoint				
Quilcene Bay (Jeff. Co.)	1984	Approved to Prohibited	200	Rural nonpoint				
Rocky Bay (Mason Co.)	8/95	Approved to Prohibited	30	Rural nonpoint	12/01	Prohibited to Approved	15	Rural nonpoint pollution corrected

Figure 3 Continued. Commercial Shellfish Growing Area Reclassifications Since 1981

Growing Area	Classification Downgrades				Classification Upgrades			
	Year	Change	Acres	Reason	Year	Change	Acres	Reason
Samish Bay (Skagit Co.)	8/94	Approved to Restricted	490	Agricultural, rural nonpoint including on-site sewage system failures				
	8/94	Approved to Prohibited	2,200	Agricultural, rural nonpoint including on-site sewage system failures	5/98	Restricted to Approved and Prohibited to Conditionally Approved	835	Repair of sewage problems in near shore communities
					7/02	Conditionally Approved to Approved	350	Improvements in nonpoint pollution sources
Sequim Bay (Clallam Co.)	2/92	Approved to Prohibited	200	Sewage treatment plant				
	2/92	Approved to Conditionally Approved	2,830	Sewage treatment plant	6/98	Conditionally Approved to Approved	2800	Sewage treatment plant upgrade and relocation of outfall
					1/00	Prohibited to Approved	750	Sewage treatment plant upgrade and relocation of outfall
Similk Bay (Skagit Co.)	7/00	Approved to Prohibited	60	Failing on-site sewage systems				
South Skagit Bay (Skagit Co.)	3/87	Approved to Restricted	6,140	Rural, agricultural nonpoint	9/93	Restricted to Conditionally Approved	2,280	Sewage treatment plant performance and correction of agricultural waste problems
Squaxin Island (Mason Co.)					7/93	Prohibited & Conditionally Approved to Approved	50	Removal of boat dock and mooring buoys

Figure 4. 2002 Reclassifications of Intertidal Shellfish Growing Areas

Growing Area	County	Classification	Acres
Grays Harbor	Grays Harbor	Conditionally Approved to Approved	479
Nisqually Reach	Thurston	Conditionally Approved to Approved	960
North Bay	Mason	Conditionally Approved to Approved	1,110
Samish Bay	Skagit	Conditionally Approved to Approved	350

According to our analysis in March of 2003, all but one commercial shellfish growing area met their current classifications. The exception was in portions of Dungeness Bay, currently classified as Approved, which had several water quality stations that failed to meet the standard. DOH is in the process of determining the appropriate classification for Dungeness Bay. In total, 19 areas were identified as “threatened” (see Figure 5). These areas include:

- Birch Bay (Whatcom County)
- Portage Bay (Whatcom County)
- Buck Bay (San Juan County)
- South Skagit Bay (Snohomish and Island Counties)
- Dungeness Bay (Clallam County)
- Port Townsend (Jefferson County)
- Port Gamble (Kitsap County)
- Hood Canal #9 (Mason County)
- North Bay (Mason County)
- Burley Lagoon (Pierce County)
- Henderson Bay (Pierce County)
- Rocky Bay (Pierce County)
- Annas Bay (Mason County)
- Oakland Bay (Mason County)
- Henderson Inlet (Thurston County)
- Eld Inlet (Thurston County)

- Grays Harbor (Grays Harbor County)
- Naselle River (Pacific County)
- Nahcotta (Pacific County)

For more information on threatened shellfish growing areas, contact Bob Woolrich at (360) 236-3329.

Fecal Coliform Status and Trends in Commercial Shellfish Beds

DOH participates with other agencies in the Puget Sound Ambient Monitoring Program (PSAMP) to assess the health of Puget Sound (see page 19 for more information on PSAMP). DOH addresses two questions for PSAMP:

- What is the status of fecal pollution in shellfish beds?
- Has fecal pollution changed over time?

To answer these questions, fecal coliform statistics used by DOH to classify growing areas (geometric means and 90th percentiles) were adapted to meet PSAMP objectives. The PSAMP procedure is nearly identical to that used for classifying growing areas. However, classification requires additional data and calculations beyond the scope of PSAMP. For

Figure 5. Threatened Shellfish Growing Areas



PSAMP, statistics were calculated for each sampling date starting from the earliest date having the minimum required number of prior results (30) forward to the most recent date available.

DOH has completed evaluation of the fecal coliform pollution status of 96 commercial shellfish growing areas in Puget Sound for the year ending in December 2002. Analysis for trends is underway but is not yet completed.

Status of fecal coliform pollution in shellfish growing areas

Nearly 1,300 stations in nearly 100 growing areas in Puget Sound were assessed for PSAMP. The status of each growing area was determined for the period from January through December 2002. Each station within a growing area was categorized according to the highest 90th percentile occurring at the sampling station during the period: **GOOD** (0-30 MPN per 100 ml), **FAIR** (31-43 MPN per 100 ml) or **BAD** (above 43 MPN per 100 ml). The fraction of sampling stations within each category was used to produce a pie chart. Pie charts for each growing area provide a means to visually compare growing areas in Puget Sound and the Straits of Georgia and Juan de Fuca (Figure 6). Drayton Harbor (near the international border), Dungeness Bay (near Sequim), and Henderson Inlet (near Olympia) appear to be the most affected by fecal pollution.

(Note: Figure 6 sorts the 98 growing areas into six regions: (1) North Puget Sound and Georgia Strait, (2) Admiralty Inlet and the

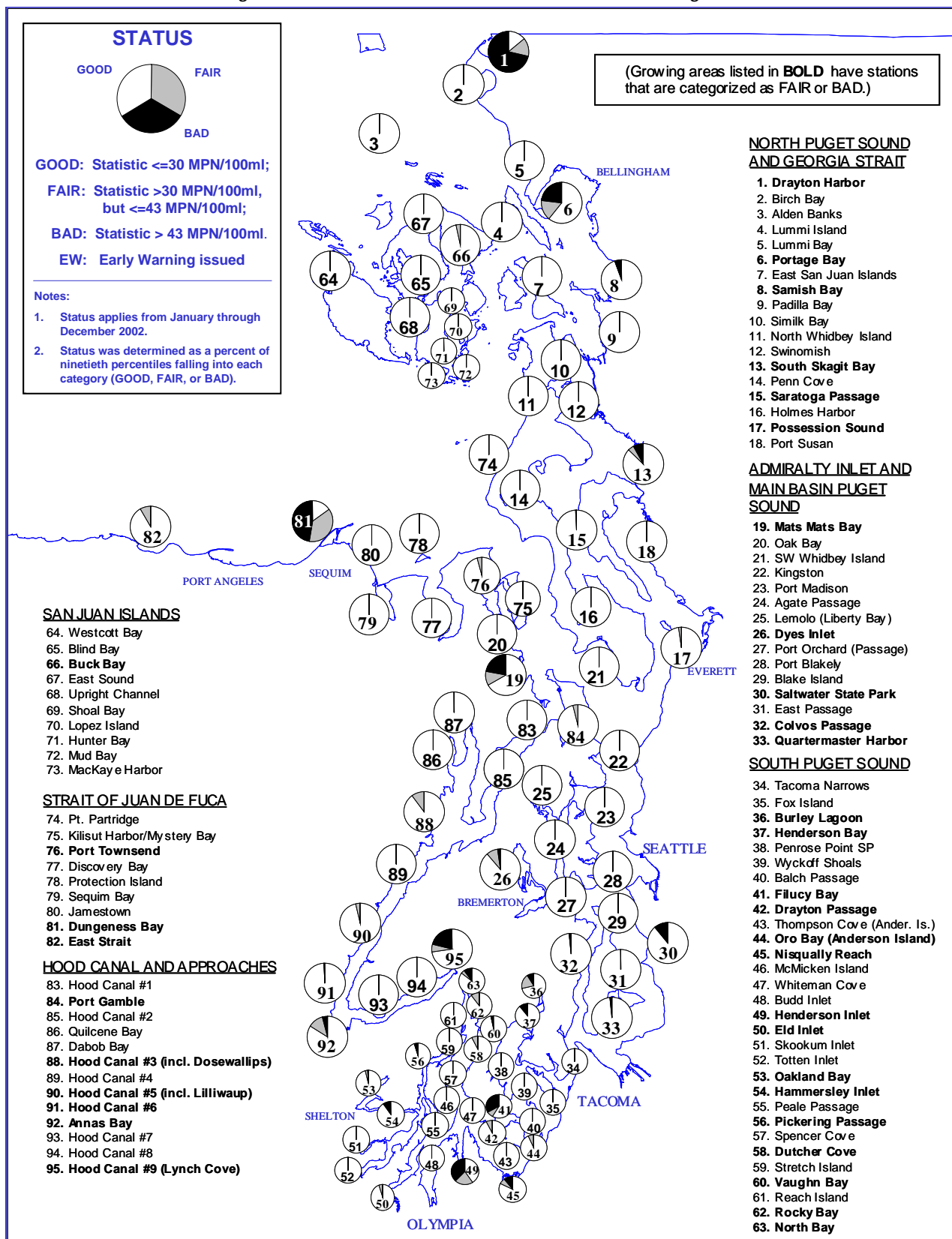
Puget Sound Main Basin, (3) South Puget Sound, (4) San Juan Islands, (5) the Strait of Juan de Fuca, and (6) Hood Canal.)

Ranking of fecal impact in growing areas and regions.

Each growing area was ranked according to fecal pollution impact by calculating a "Fecal Pollution Index" or FPI. First, the fraction of stations within each category was multiplied by a corresponding weighting factor (GOOD: 1.0; FAIR: 2.0; or BAD: 3.0). Next, the resulting weighted fractional values are added to produce the FPI. In simple terms, if 100% of the stations in the growing area are GOOD, the index is 1.0 (1.00 x 1.0). On the other hand, an index of 3.0 means 100% of the stations are BAD (1.00 x 3.0). A growing area with a mixture of categories falls between the extremes. Figure 7 arrays the indices of 36 growing areas (over a third of the total) with indices greater than 1.0. The bar graphs agree with our visual impressions from Figure 6. Drayton Harbor has been affected the most (FPI = 2.6), followed by Dungeness Bay (FPI = 2.2), then by Henderson Inlet (FPI = 1.9). Several growing areas were added to the list of impacted areas this year: Buck Bay (San Juan Islands, FPI = 1.03) and Port Townsend (FPI = 1.05). Eld Inlet and Oakland Bay, which received extensive cleanup efforts in the past, are "holding their own" (FPI = 1.05 each).

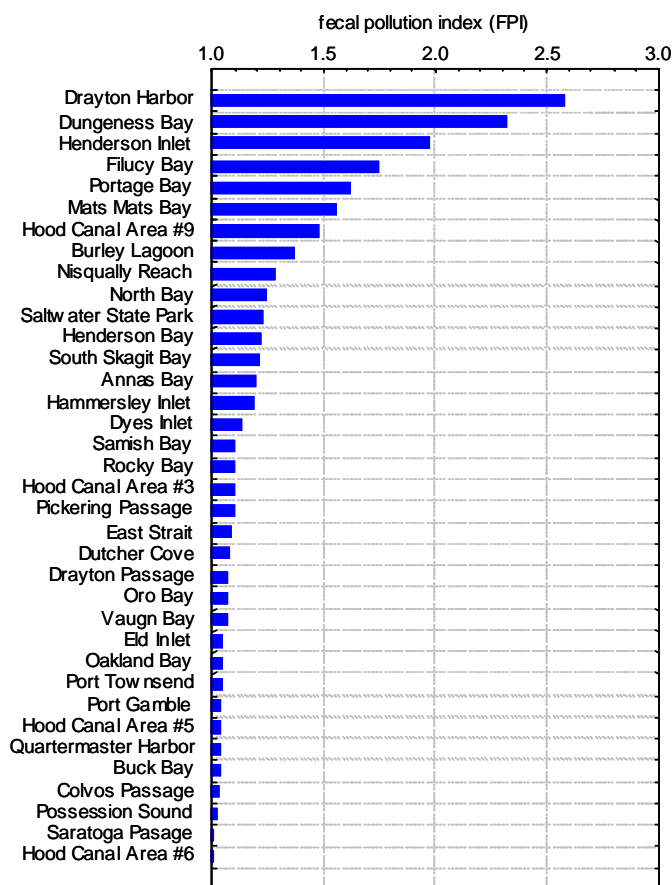
The concept of calculating FPI was extended to the level of the region. For each region the total of stations within each category (GOOD, FAIR, BAD) was calculated. Next, the

Figure 6. Fecal Coliform Pollution in Shellfish Growing Areas



weighted proportion of stations in each category was determined as described earlier. The weighted proportions were summed to produce an FPI for each of the regions: South Puget Sound had the highest pollution impact (FPI = 1.25). North Puget Sound/Georgia Strait nearly tied for second place with the Strait of Juan de Fuca (FPI = 1.14 and 1.16, respectively). Following in succession were Hood Canal (1.060), Admiralty Inlet and the Main Basin (1.031), and the San Juan Islands (1.002).

Figure 7. Shellfish Growing Areas Ranked by Fecal Pollution Index



Closure Zone Determinations

Shellfish are filter feeders and they can accumulate and concentrate nearby disease-causing organisms. Therefore it is important that the public be protected from consuming shellfish located near actual and potential sources of pollution. Closure zones are established by DOH around sources of pollution to prevent harvest and consumption of contaminated shellfish. Typical sources are sewage treatment plants, marinas, and nonpoint sources such as river discharges or runoff from watersheds following heavy rainfall. For example, there are more than 60 sewage treatment plant outfalls discharging to the marine waters of the state, some near shellfish growing areas. The daily discharge from these treatment plants varies greatly, from tens of thousands of gallons at small plants to over one hundred million gallons at the larger facilities.

DOH conducts a technical evaluation for each sewage treatment plant and marina located near an area of commercial or public recreational shellfish harvest. Evaluations for each potential pollution source include inspection of the facility by the DOH engineer, gathering information on water currents and characteristics near the site, and evaluating the dilution and dispersion of any wastewater discharged from the facilities. Frequently DOH conducts its own studies to better understand the movements of marine waters in the area if such information is not available, or works with the consultants of these facilities to generate the information. DOH studies can include

the measurement of dye injected into a treatment plant's discharge by boat-mounted equipment, and the use of fix-depth floats to study the dilution, current speed and direction in the nearby marine waters. DOH uses the information, collected at marinas and sewage treatment plants, in computer models to calculate the size of closure zone for each facility, using the protective assumption that an unplanned upset event or waste discharge has occurred. In addition, each sewage treatment plant is required to call DOH immediately if a bypass occurs, or if a problem occurs with the disinfection system. In turn, DOH may close the area near a pollution discharge to commercial and public recreational shellfish harvesting, and contacts stakeholders such as county health departments, tribal and non-tribal shellfish harvesters, and the Washington State Department of Fish and Wildlife. Using this approach, the public is protected from consuming contaminated shellfish near potential pollution sources, even during unusual conditions. For more information contact Frank Meriwether at (360) 236-3321.

SHELLFISH GROWING AREA RESTORATION PROGRAM

The goal of the DOH Shellfish Office Restoration Program is to reopen commercial and recreational shellfish beds that have been closed or have harvest restrictions and to prevent the closure of shellfish areas that are still open but threatened. The Restoration Program works cooperatively with entities such as local governments, the Puget Sound

Water Quality Action Team, Tribes, and the Department of Ecology. Program activities include notifying affected parties about classifications that are threatened, water quality testing, participating in surveys to identify pollution sources, serving as a member or advisor on watershed committees, and assisting in the development of watershed management plans and closure response plans.

Restoration Projects

DOH Restoration Program projects in 2002 included:

Nisqually Reach (Thurston County) In 2002, pollution source improvements by Thurston County and the Thurston Conservation District and improved water quality enabled DOH to upgrade the classification of 900 acres of Conditionally Approved and 60 acres of Restricted shellfish beds to Approved. DOH is monitoring marine water, the Nisqually River, and McAllister Creek monthly to assist in pollution source identification.

Henderson Inlet (Thurston County) DOH is monitoring marine water quality monthly to track changes in pollution conditions and is working with the county to identify and correct pollution sources.

Dungeness Bay (Clallam County) DOH continues to support efforts by county, state, tribal, and federal agencies to identify and correct the pollution sources responsible for the 2000 and 2001 downgrades.

Lower Hood Canal (Mason County) Work on a new on-site sewage system began at Belfair State Park, which is immediately adjacent to a Prohibited area. DOH and Mason County continue efforts to identify the pollution sources in the Prohibited portion of Lower Hood Canal.

Burley Lagoon (Pierce and Kitsap Counties) In 2001, the southern portion of Burley Lagoon (110 acres) was reclassified from Restricted to Approved. Pierce and Kitsap Counties continue to investigate, find, and correct pollution problems in the watershed to maintain the Approved classification and to upgrade the Restricted area in the northern part of the bay. DOH continues monthly monitoring of marine and stream water quality and conferring with county agencies.

North Bay (Mason County) The installation of a community sewage treatment plant with upland disposal and improved water quality allowed DOH to upgrade 1,110 acres of North Bay from Conditionally Approved to Approved. DOH continues to monitor marine water quality monthly and working with Mason County to locate pollution sources along the shoreline next to the town of Allyn.

Filucy Bay (Pierce County) DOH downgraded seven acres from Conditionally Approved to Restricted in 2001. Ongoing restoration work in the watershed includes testing of on-site sewage systems and investigations of animal keeping practices. DOH conducts monthly marine water and stream sampling in cooperation with the Tacoma-Pierce County Health Department.

Drayton Harbor (Whatcom County) The last remaining open part of Drayton Harbor was downgraded to Prohibited in 1999 due to poor water quality. DOH continues to work with the Citizens Watershed Committee, the City of Blaine Public Works Department, various Whatcom County agencies, and the Northwest Indian College to solve a complex set of pollution problems.

Portage Bay (Whatcom County) Water quality continues to improve in the Nooksack River watershed and in the shellfish growing area in Portage Bay due to extensive work by Lummi Natural Resources, Northwest Indian College, Department of Ecology, and Whatcom County Water Resources. DOH continues to work with these entities toward an upgrade of the Restricted area.

Samish Bay (Skagit County) Work by the Skagit County Health and Public Works Departments resulted in improved water quality and an upgrade of the 350 acres of Conditionally Approved area to Approved in July 2002. DOH continues cooperative monthly water quality sampling with these county agencies.

Similk Bay (Skagit County) Following the downgrade of 60 acres of the northwest portion of Similk Bay in 2000, the Skagit County Health Department dye-tested the on-site septic systems of the Similk Beach community and found a high percentage of failures. County agencies are planning a community sewage system.

For further information on the Restoration Program, contact Don Melvin at (360) 236-3320.

PUGET SOUND AMBIENT MONITORING PROGRAM

The Department of Health Office of Food Safety and Shellfish Programs participates in the Puget Sound Ambient Monitoring Program (PSAMP). The goals of PSAMP are to:

- Assess the health of Puget Sound and its resources;
- Identify existing environmental problems;
- Provide data to help the Puget Sound Water Quality Action Team and others measure the success of environmental programs;
- Provide a permanent temporal record of significant natural and human-caused changes in key environmental indicators in Puget Sound; and
- Support research activities by making available scientifically valid data.

The primary goal of DOH is to assure the health and safety of shellfish consumers. Information gathered by DOH programs can also be used to meet the broader goals of PSAMP.

Data are drawn from two office programs: the Biotoxin Monitoring Program and the Commercial Areas Water Quality Monitoring Program.

During the past year, the PSAMP analysis has been publicly presented through DOH technical reports, the 2002 Puget Sound

Update (published by the Puget Sound Action Team), and posters and presentations at community fairs (2002 Oysterfest and the Dungeness River Festival).

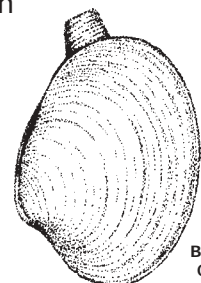
LICENSING AND CERTIFICATION PROGRAM

DOH's Shellfish Licensing and Certification Program is a statewide program designed to protect the public health by licensing all commercial bivalve molluscan shellfish companies and certifying all harvest sites in Washington State. This program ensures that standards are met in the harvesting, handling, processing, packaging, buying, storage, and distribution of shellfish. Through formal agreement with the Department of Fish and Wildlife, shellfish growing areas are patrolled to prevent the illegal harvest of shellfish from unsafe, polluted waters.

Washington State Shellfish Industry

Washington State is among the top shellfish producing states in the nation, and is recognized as having one of the nation's safest supplies of shellfish. The success in assuring that Washington shellfish are among the safest in the nation is due to the cooperative efforts of DOH, the Washington Tribes, and the shellfish industry.

The commercial shellfish license year runs from October 1 through



BUTTER
CLAM

September 30 each year for Shellstock Shippers and Shucker Packers. Harvester licenses run from April 1 through March 30 each year. The Washington state shellfish industry currently consists of approximately 330 licensed, certified shellfish operations. Twenty-five firms are licensed as shucker-packers (shellfish processing firms), 178 as shellstock shippers, and 127 firms are licensed as harvesters. DOH performed 632 routine inspections of licensed shellfish operations during the 2001-2002 license year.

Shucker-Packers

Shucker-packer firms either harvest or purchase shellstock, then process it in their plants by shucking, washing, and packing the meats for sale to retail markets. These processing plants are inspected for shellfish sanitation compliance a minimum of four times a year. DOH performed 104 inspections on shucker-packer firms during the 2001-2002 license year.

Shellstock Shippers

Shellstock shipper firms either harvest, purchase or reship shellstock for sale to retail markets or to other shellfish dealers. Their licenses are limited to the sale of shellstock or shucked shellfish from other licensed shucker-packer dealers; these firms are not permitted to shuck shellfish. Shellstock shipper firms are



MANILA
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inspected a minimum of two times per year. DOH performed 401 inspections on shellstock shipper firms

during the 2001-2002 license year.

Harvesters

Harvester firms are limited to harvesting shellstock and selling it intrastate (only within the state of Washington) to licensed shucker-packer or shellstock shipper firms. They are not permitted to purchase shellstock, or to sell it at the retail level. Harvesters are not permitted to shuck or store shellstock. Harvester operations are inspected once per license year. DOH performed 127 inspections of harvester firms during the 2001-2002 license year.

TRIBAL SHELLFISH SANITATION PROGRAM

2002 began the ninth year of the Tribal Shellfish Sanitation Program since the *U.S. v. Washington* shellfish subproceeding commenced in the United States District Court of Western Washington. Progress has been made in establishing and maintaining a cooperative program with the Tribes and DOH. In 2002, fourteen treaty tribes were certified and licensed by the Department. Those licensed as harvesters were the Lower Elwha Klallam Tribe, the Makah Tribe, the Muckleshoot Tribe, the Nisqually Tribe, the Port Gamble S'Klallam Tribe, the Puyallup Tribe, the Squaxin Island Tribe, and the Tulalip Tribes. Those licensed as interstate shellstock shippers were the Jamestown S'Klallam Tribe, the Lummi Indian Nation, Skokomish Tribe, Suquamish Tribe, and the Skagit System Cooperative. Three Tribes - the Upper Skagit Tribe, Sauk-Suiattle Tribe, and Swinomish

Tribe - make up the Skagit System Cooperative. The Quinault Indian Nation was a licensed shucker-packer operation. Thirty-four (34) individual tribal operations, owned and operated by tribal members, have applied for and received shellfish operation certificates of approval. All of the certified Tribal shellstock shipper or shucker-packer operations have developed Hazard Analysis Critical Control Point (HACCP) Plans.

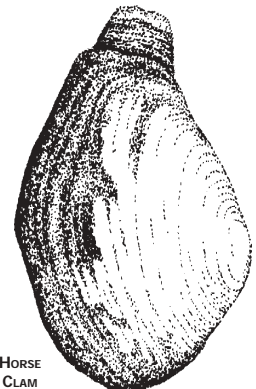
Ongoing DOH/Tribal technical meetings have continued the joint cooperation in protecting public health. These meetings have produced protocols, which include the harvest of wild seed, the harvest of molluscan bivalve shellfish for bait, and the protection of public health from the harvest and sales of non-molluscan shellfish species. Other technical issues have arisen such as biotoxin testing for crab and in the visceral ball of the geoduck clam. Through the cooperative efforts of DOH and the Tribes, annual lists of tribal growing area classification requests, which include growing areas where Tribes desire to harvest shellfish, are no longer needed. As the Tribe(s) establishes an interest in a growing area, the Tribe(s) notify DOH in writing, requesting the area be classified, if not already classified. Before any harvest, each beach or geoduck tract classification request is reviewed under the requirements of the National Shellfish Sanitation Program (NSSP). Tribal personnel continue to assist with water quality monitoring for this task. Continued development of joint protocols and training, as needed, are priorities for this program. Through joint efforts, a process for Harvest Site Application and Certification of

Private Owned Tidelands was developed and adopted.

Tribal geoduck harvesting operations exist in the Strait of Juan de Fuca, Hood Canal, and central and south Puget Sound. Geoduck boats and product landings are inspected for sanitation and proper handling of commercial product. Tribal monitors and patrol officers are working with DOH to ensure a safe product by enforcing rules for harvesting in open approved areas only. The tribes also supply geoduck for biotoxin sampling, and tribal and non-tribal harvesters share the results of analyses.

Continued cooperation between local health jurisdictions and Tribes has been enhanced with consolidated contracts that DOH has managed. Clallam County Department of Health and Human Services and the Jamestown S'Klallam Tribe are working together to look for potential pollution sources in the Dungeness River watershed. The Lummi Indian Nation and Whatcom County Health Department are jointly monitoring the Nooksack River for potential pollution sources. Continued cooperation between local jurisdictions and the Tribes is ensuring shellfish growing areas remain open and approved.

In addition to establishing programs specific to commercial endeavors, cooperative efforts also benefit subsistence and recreational shellfish harvesters. The Quileute



HORSE
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Tribe continues to conduct a coastal biotoxin monitoring program funded by the federal government. The Tribes contract with DOH's biotoxin laboratory to test for paralytic shellfish poison (PSP) and domoic acid in shellfish collected on several north Pacific Coast beaches. The results are shared with all coastal shellfish harvesters. Tribal sampling helped identify that domoic acid levels in razor clams were rising to record levels in 1998.

Overall, tribal involvement continues to result in increased public protection through shellfish food safety and awareness of Washington shellfish sanitation issues. For more information, please contact Helen Seyferlich at (360) 236-3323.

VIBRIO PARAHAEMOLYTICUS IN WASHINGTON STATE

DOH implements portions of the 2001 ISSC Conference Interim *Vibrio parahaemolyticus* plan.

Routine shellfish testing is part of the control plan. Figure 8 shows the results of routine sampling of oysters from four representative commercial growing areas in Washington with significant levels of *Vibrio parahaemolyticus* (V.p.) during the summer of 2002.

Vibrio Illnesses

There were a total of 18 confirmed cases of vibriosis linked to Washington molluscan shellfish during 2002. Of these:

- 5 cases were linked to oysters commercially harvested in Washington.
- 3 cases were linked to oysters recreationally harvested in Washington.
- 10 cases were linked to product from multi-source locations that included Washington product.

There were no confirmed cases of vibriosis linked to products from out-of-state.

Figure 9 provides a breakout of the illness information relating to each category for 2002.

Figure 8. 2002 *Vibrio Parahaemolyticus* Levels

Area V.p. > 100	Level	Date
Hammersley Inlet	141	7/08/02
Hammersley Inlet	>42,500	8/05/02
Hood Canal N. (Quilcene)	240	7/01/02
Hood Canal N. (Quilcene)	>42,500	9/08/02
Hood Canal S. (Eagle Creek)	933	7/28/02
Hood Canal S. (Eagle Creek)	>42,500	9/03/02
Samish Bay	292	8/12/02
Samish Bay	11,000	8/26/02

MARINE BIOTOXIN MONITORING PROGRAM

The state of Washington routinely experiences seasonal restrictions on commercial and recreational shellfish harvest due to paralytic shellfish poisoning (PSP), more commonly known as "red tide." The biotoxin that causes PSP temporarily interferes with the transmission of nerve impulses in warm-blooded animals. The primary symptoms of

Figure 9. 2002 *Vibrio Parahaemolyticus* Illnesses

	Commercial WA Oysters	Recreational WA Oysters	Commercial Multi-Source Including WA Oysters
Number of Confirmed Cases	5	3	10
Number Ill by Harvest Site	1 - Potlatch Area 2 - Oysterville 45N 1 - Oakland Bay 1 - N. Hood Canal	1 - Mosquito Pass 1 - Stewart Island 1 - S. Hood Canal	Multiple locations
Harvest Dates	7/12/02 - 8/23/02	7/22/02 - 8/18/02	7/14/02 - 8/13/02
How Consumed	1 - raw shucked meats 4 - raw shellstock	1 - fried shellstock 1 - raw shellstock 1 - BBQ shellstock	1 - shucked meats * 1 - half shell * 8 - raw shellstock

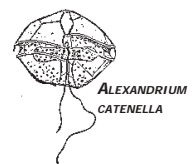
* Preparation method unknown

PSP in humans are numbness and tingling of the lips, tongue, face and extremities, difficulty talking, breathing, swallowing, and muscle incoordination. Symptoms develop quickly, usually within 1-2 hours of consumption (very high levels of toxin can produce symptoms within 30 minutes), and typically disappear within 12-24 hours. There is no known antidote for the toxin. Treatment is basically supportive, i.e., artificial respiration, in life threatening cases.

PSP toxin is produced by microscopic organisms that naturally exist in marine water. The species that causes PSP in Washington marine waters is *Alexandrium catenella*. *Alexandrium* is usually present in small numbers; however, when environmental conditions are optimum, rapid reproduction occurs. Filter-feeding shellfish, which include clams, oysters, mussels, and scallops, can

accumulate the toxin to dangerous levels during these "blooms."

DOH monitors PSP toxin levels in shellfish from areas throughout the state. Commercial companies submit PSP samples as a condition for commercial certification. Recreational beaches are sampled as a cooperative effort between DOH, other state agencies, Tribes, and health departments, often utilizing citizen volunteers. Areas are closed for harvest of molluscan shellfish when PSP toxin levels equal or exceed the Food and Drug Administration standard of 80 micrograms toxin/100 grams shellfish tissue. Areas are not reopened until testing has confirmed that the PSP toxin has declined to a safe level. Butter clams (*Saxidomus giganteus*) may experience extended closures because they typically retain the PSP toxin longer than other shellfish. A recreational



razor clam season may be held each spring and fall depending on biotoxin levels and availability of resource.

The DOH Shellfish Office maintains a toll free 24-hour "PSP Hotline" (1-800-562-5632) identifying recreational beach closures. Local health jurisdictions also issue notices through local newspapers and radio. Beach posting is irregular depending on jurisdiction, beach ownership, and susceptibility to vandalism and theft, and is not a reliable method of notification.

2002 PSP Summary

The Washington State Public Health Laboratory analyzed 3,374 PSP samples in 2002. Commercial shellfish growing areas were monitored biweekly during 2002. Selected recreational beaches were monitored biweekly from April through October by local health jurisdictions, Clallam County Marine Resource Council, Puget Sound Restoration Fund, and other volunteers. Sentinel mussel cage sites were monitored year-round.



RAZOR
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First Quarter 2002

PSP toxin levels followed the typical pattern for the first quarter of the year, with downward trends throughout the state, followed by area closures being lifted. In Puget Sound, general closures were lifted in Clallam,

Island, Jefferson, King, Kitsap, and Snohomish Counties. There were four geoduck tract closures in the first quarter of 2002. PSP levels in razor clams were absent for the entire coast except for Long Beach, where it ranged from 40 to 60 micrograms.

Second Quarter 2002

The ongoing downward trend in PSP toxin continued during April and May, with many area closures being lifted or reduced from "all species" closures to "butter clam only" closures. However, this trend ended abruptly at the end of May, with the onset of a PSP bloom in North Puget Sound. It began in Whatcom County from the Canadian border to Birch Bay and expanded into San Juan County. However, the bloom was short in duration and was in decline by the end of June. At the end of the second quarter of 2002, PSP activity was still absent in most parts of the state. There were six geoduck tract closures in the second quarter of 2002. This year's low PSP activity closely resembles 1995, which was a quiet year for PSP.

For the first time in over fifty years, the west Strait of Juan de Fuca was open in May and most of June. This was due to the rescinding of the Fish & Wildlife regulation, which automatically closed the area every year from April 1 to October 31. The closure was initiated after three PSP deaths in 1942 occurred from consumption of shellfish from the Strait of Juan de Fuca, and remained in effect until May 2002.

Third Quarter 2002

The lack of PSP activity was the most notable feature for most of the third quarter of 2002. There were no major intertidal commercial area closures in this quarter. However, there were ten commercial geoduck tract closures. Some of the tract closures were without the typical accompanying intertidal PSP activity that is usually seen in the summer months.

There were a number of recreational closures, mostly the result of elevated blue mussel test results. These blooms were generally very brief in duration and did not have much of an effect on other shellfish species. Closures occurred in Jefferson County in July and in Kitsap and Pierce Counties in August.

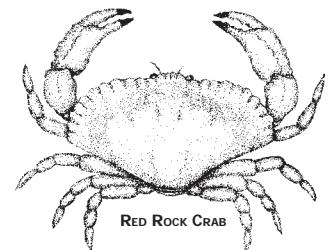
At the first of September, PSP activity increased with closures in King, Clallam, Kitsap, and Jefferson Counties. However, the second week of September was just the opposite of the first week, with numerous areas reopening. In the third week, PSP activity again increased, closing areas in Kitsap, Pierce, King, Clallam, Skagit, and Jefferson Counties. The persistent calm, sunny days of September were merely setting the stage for powerful blooms to follow in October.

Fourth Quarter 2002

The mild, dry weather characteristic of September continued for the month of October and into November, which provided the opportunity for strong PSP blooms in a number of areas of the state. There were

nine additional geoduck tract closures and seven major commercial shellfish area closures in the last quarter of 2002. Six of the seven commercial closures were in the north part of the state. In the second week in October, PSP blooms closed Portage Bay in Bellingham Bay in Whatcom County and Samish Bay in Skagit County. Portage peaked at 192 micrograms in Blue Mussels, while Bellingham Bay proper reached 1,422 micrograms. Pacific Oysters in Samish Bay peaked at 427 micrograms. The last four northern closures, bordering on the Olympic Peninsula, occurred in the third week in October. Blue Mussels peaked at 822 micrograms in Sequim Bay (Clallam County) and at 887 micrograms in Discovery Bay (Jefferson County). November saw a dramatic increase in PSP levels, with Mystery Bay in Jefferson County reaching 20,751 micrograms and Scow Bay in south Kilisut Harbor peaking at 8,391 micrograms. The Mystery Bay bloom has the distinction of being the second most toxic PSP bloom in Washington's history, only surpassed by the Island County bloom of 1978, which exceeded 30,000 micrograms of PSP toxin. The Scow Bay bloom set a new PSP toxin record for that area.

The last commercial closure for 2002, affecting parts of Mason and Pierce Counties, occurred in Case Inlet in South Puget Sound in November. The bloom began in October, but the toxin did not reach closure levels until the first



week in November. By the third week of November, at the height of the bloom, mussels peaked at 1,773 micrograms at Allyn, 1,060 micrograms at Stretch Island and geoducks peaked at 1,001 micrograms at Stretch Island.

Generally, the recreational closures followed the commercial closure trends in the fourth quarter of 2002. They began in October, with closures in the north. Parts of Jefferson and Skagit Counties, all of Whatcom County, and parts of San Juan County closed in the first half of October. Also, an unusual bloom occurred in north Hood Canal, which was very localized at Lofall, that closed part of Kitsap County. In the last half of October, North Case Inlet closed while Dyes Inlet in Kitsap County reopened.

In November, recreational area closures occurred in Mason, Pierce, and Thurston Counties. In late November, North Willapa Bay was closed for recreational harvest of all shellfish species. As the blooms began to

wind down in November, numerous areas reopened to recreational shellfishing. By December, the blooms had come to a stop and areas continued to reopen. They included Whatcom County, Willapa Bay in Pacific County, and the Nisqually Reach in Thurston County. Parts of Jefferson County and Kitsap Counties remained closed for butter clams only.

Even though the algal blooms were over, shellfish in parts of Clallam, Jefferson, Mason, and Pierce Counties continued to contain high levels of PSP toxin at years' end. The highest PSP levels for the year are listed in Figure 10.

Sentinel Mussel Monitoring Program

The Department of Health continued the Sentinel Mussel Monitoring Program as an early warning system for marine biotoxins in 2002. With assistance from local health jurisdictions, Tribes, Puget Sound Restoration

Figure 10. Areas of Highest PSP Levels in 2002

Date	Harvest Area	Species	Toxin Level*
11/03/02	Mystery Bay, Kilisut Harbor	Blue Mussel	20,751
11/17/02	Scow Bay, Kilisut Harbor	Blue Mussel	8,391
10/01/02	Dockton, Quartermaster Harbor	Blue Mussel	2,985
11/11/02	Mystery Bay, Kilisut Harbor	Manila Clam	2,265
11/19/02	Allyn, Case Inlet	Blue Mussel	1,773
10/02/02	Squalicum Harbor	Blue Mussel	1,422
11/19/02	Stretch Island Bridge, Case Inlet	Blue Mussel	1,060
11/20/02	Stretch Island, Case Inlet	Geoduck Clam	1,001

* Micrograms per 100 grams tissue

Figure 11. 2002 Sentinel Biotoxin Mussel Sites



Fund and other volunteers, 66 collection sites were maintained and monitored biweekly to monthly. Figure 11 shows the collection site locations used in 2002.

In addition to the sentinel mussel locations, commercial mussels were routinely monitored at Westcott Bay at San Juan Island and Penn Cove and Holmes Harbor at Whidbey Island.

Domoic Acid

Domoic acid is a naturally occurring toxin produced by species of microscopic marine diatoms of the genus *Pseudo-nitzschia*. The human illness known as amnesic shellfish poisoning (ASP) or domoic acid poisoning (DAP) is caused by eating fish, shellfish, or crab containing the toxin. Symptoms include vomiting, nausea, diarrhea, and abdominal cramps within 24 hours of ingestion. In more severe cases, neurological symptoms develop within 48 hours and include headache, dizziness, confusion, disorientation, loss of short-term memory, motor weakness, seizures, profuse respiratory secretions, cardiac arrhythmias, coma, and possibly death. There is no antidote for domoic acid poisoning.

ASP was first characterized in 1987 on the Atlantic Coast of Canada. Domoic acid was first detected on the Pacific Coast in California in the summer of 1991, when a number of pelican and cormorant deaths were linked to domoic acid in anchovies. In the fall of 1991, domoic acid was detected in razor clams off the coast of Washington. This discovery

brought a premature end to the recreational razor clam harvest but not before several mild cases of ASP were associated with the consumption of razor clams.

Domoic acid levels are measured using a laboratory technique called high performance liquid chromatography (HPLC). The level of domoic acid determined to be unsafe for human consumption is 20 ppm in molluscan shellfish and 30 ppm for Dungeness crab viscera. The Dungeness crab areas are closed when three of six individual crab viscera equals or exceeds 30 ppm. Research shows that razor clams accumulate domoic acid in the edible tissue (foot, siphon, and mantle) and are slow to rid themselves of the toxin. In Dungeness crab, domoic acid primarily accumulates in the viscera.

In 1991, DOH began monitoring all major shellfish growing areas for domoic acid. With one exception, unsafe levels of domoic acid have only been detected in coastal razor clams and dungeness crab. That one exception was a California mussel sample from Clallam County's Second Beach, an outside coastal beach that tested 34 ppm in September 1998. Unsafe levels have not been detected in any other species of coastal shellfish, nor have they been detected in unsafe levels in the coastal estuaries of Grays Harbor, Willapa Bay, or the inland waters of the Strait of Juan de Fuca, the San Juan Islands, or Puget Sound.

2002 Domoic Acid Summary

Approximately 99 crab and 1,035 molluscan shellfish samples were tested for domoic acid in 2002.

First Quarter 2002

The domoic acid levels in razor clams for the first quarter of 2002 remained low, with just single digit test results. The plankton monitoring revealed almost no *Pseudo-nitzschia* cells present in the water. This allowed the recreational razor clam season to continue with 14 harvest days at Long Beach, 13 days at Copalis and Kalaloch, 11 days at Twin Harbors, and 10 days at Mocrocks. Because domoic acid in Dungeness crab from the outside coast was almost non-existent in the fall of 2001, plus the fact that the razor clam toxin levels were very low, coupled with very low *Pseudo-nitzschia* plankton observations, a suspension of crab testing for the first quarter of 2002 was possible.

Second Quarter 2002

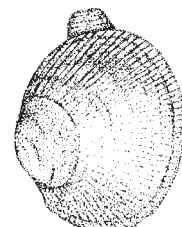
The second quarter of 2002 continued the trend of the first quarter 2002. Long Beach, Twin Harbors, and Copalis each had nine additional harvest days. Kalaloch had eight harvest days and Mocrocks had six harvest days. The difference in the number of days at each area was due to resource considerations, not toxin levels. In May, the plankton counts began to rise, prompting additional sampling. However, the toxin levels remained stable. The commercial razor clam season for the Willapa Spits began on May 12, 2002 and continued until June 30, 2002.

An abundance of clams coupled with low toxin levels for the winter 2001/spring 2002 razor clam season produced an outstanding recreational harvest opportunity. Washington Department of Fish & Wildlife published the following statistics for the season. A total of 307,000 digger trips harvested 4.3 million razor clams resulting in the best season since 1995. A high digger success rate of 14.1 clams per digger trip and an average clam size of 4.9 inches made for very satisfied clam harvesters. It is estimated that the 2001-2002 recreational razor clam season generated 7.7 million dollars for the coastal communities.

Third Quarter 2002

Razor clam samples continued to register low readings for domoic acid in most of the third quarter. The plankton monitoring, which revealed low levels of *Pseudo-nitzschia* cells in the water, supported the low toxin results in the clams. However, during the last part of September, plankton monitoring revealed a sudden increase in *Pseudo-nitzschia* cell counts, which was followed by elevated toxin levels in the razor clam samples. The toxin levels for Kalaloch, Copalis, and Mocrocks were all above 20 ppm. These results prevented the opening of the razor clam season in the first week of October.

At the same time, Twin Harbors and Long Beach tested 16 ppm for domoic acid, which was an eight-fold increase in one week. Because of the fast rise in toxin, the



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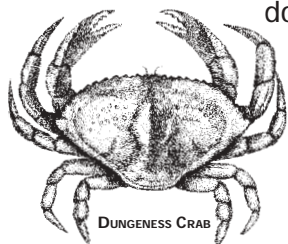
season opening was postponed for these two beaches, even though the standard of 20 ppm had not been reached. However, when sampling of these two beaches was conducted a week later, during the time when they would have been open, Twin Harbors had a test result of 60 ppm and Long Beach reached 38 ppm, both well above the standard of 20 ppm.

Fourth Quarter 2002

The upward trend in toxicity in razor clams that began in September continued and peaked in October. The highest result, 188 ppm, was recorded at Mocrocks in the fourth week of October. In the same week, Copalis peaked with a result of 185 ppm, Long Beach had a result of 132 ppm, and Twin Harbors topped out at 113 ppm. Kalaloch peaked in the first week in November at 150 ppm. Almost immediately after the peaks in October and early November, plankton sampling revealed a dramatic decrease in *Pseudo-nitzschia* cell counts. Consequently, all razor clam samples began to drop in toxicity as well, although none fell below 115 ppm by years' end. The complete shutdown of the fall razor clam season represented a significant economic blow to the coastal communities.

The elevated toxin levels in the razor clams also had a significant impact on the Dungeness Crab Monitoring Program. The early October, pre-season crab samples had low (single digit) domoic acid test results.

However, as the clam samples gained in



toxicity, so did the crab samples. By mid-November, the crab samples (crab viscera are tested for domoic acid) were producing many test results in the 20 ppm to 40 ppm range with a few over 40 and one at 52 ppm. Three individual crab in a set of six testing at 30 ppm or higher would close the crab season or at best require all crab to be eviscerated before being sold. Fortunately, domoic acid remains almost entirely in the viscera, with very little transferring to the meat. The most toxin recorded in the meat was 4 ppm, well below the FDA standard of 20 ppm for domoic acid in crabmeat. Because of the elevation in toxicity, crab monitoring was increased from monthly to weekly.

The highest domoic acid levels for the year are listed in Figure 12.

For more information on PSP and Domoic Acid contact Frank Cox at (360) 236-3309.

Summary of PSP Status for PSAMP

Each year DOH analyzes spatial and temporal trends in PSP for the Puget Sound Ambient Monitoring Program (PSAMP). This year, DOH has examined for PSAMP the results of 31 of its Sentinel Monitoring Sites for Paralytic Shellfish Poisoning (PSP) toxin in Puget Sound and the Straits of Georgia and Juan de Fuca. PSP toxin is measured in mussels collected at each sentinel site. The analysis covers the period from 1991 through 2002.

Figure 12. Areas of Highest Domoic Acid Levels in 2002

Date	Harvest Area	Species	Toxin Level*
10/21/02	Mocrocks Area BC	Razor Clam	188
10/20/02	Copalis Area K	Razor Clam	185
11/04/02	Kalaloch Beach North	Razor Clam	150
10/21/02	Long Beach Reserve	Razor Clam	132
10/20/02	Twin Harbors Area G	Razor Clam	113

* parts per million

Figure 13 shows PSP results for calendar year 2002 from each Sentinel site sorted into PSP impact categories (as defined in the legend). A pie chart summarizes the fraction of results in each category at each Sentinel site. Eighteen of 31 Sentinel sites had at least minimum PSP impact, compared to 24 of 34 sites reported in last year's Annual Inventory. (Three sites were dropped due to budget reductions.)

Figure 14 compares PSP impact at Sentinel sites in 2001 and 2002. An "Impact Factor" developed by DOH was used to make between-year comparisons. Fourteen sites were lower this year; ten were higher, and seven sites remain unchanged. Two of four sites in north Puget Sound and the Strait of Georgia were higher this year. Five of six Sentinel sites in the Strait of Juan de Fuca and Admiralty Inlet were higher in 2002 compared to 2001. Eight of ten Sentinel sites in the Main Basin were lower, although Quartermaster Harbor (Vashon Island) was higher. Four of six sites in South Puget Sound showed lower PSP and two (North Bay and Burley Lagoon) were

higher. Hood Canal south of Lofall and eight other sites scattered throughout Puget Sound were clear of PSP.

RECREATIONAL SHELLFISH PROGRAM

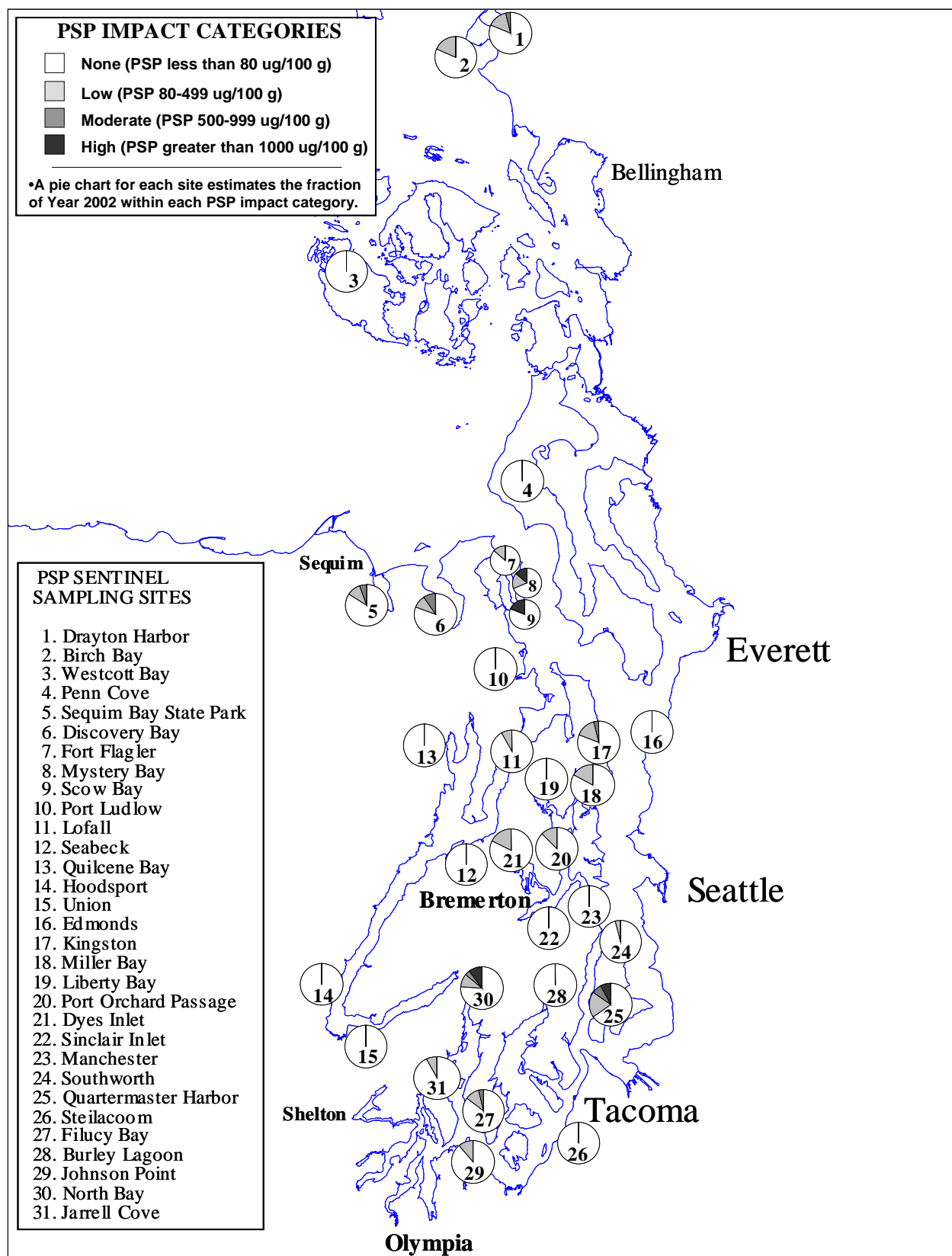
The goal of the Recreational Shellfish Program is to protect the health of recreational harvesters by providing them with sufficient information to make informed decisions about where and when it is safe to harvest shellfish.

Consolidated Contracts

Local health jurisdictions play an important role in protecting the health of recreational shellfish harvesters. All 12 Puget Sound counties received funding through their consolidated contract with DOH for recreational shellfish activities.

Local participation in biotoxin sampling is a key component of the contracts. The percentage of Puget Sound biotoxin samples

Figure 13. 2002 PSP Sentinel Sites Results



collected by local health jurisdictions stood at 27% for 2002.

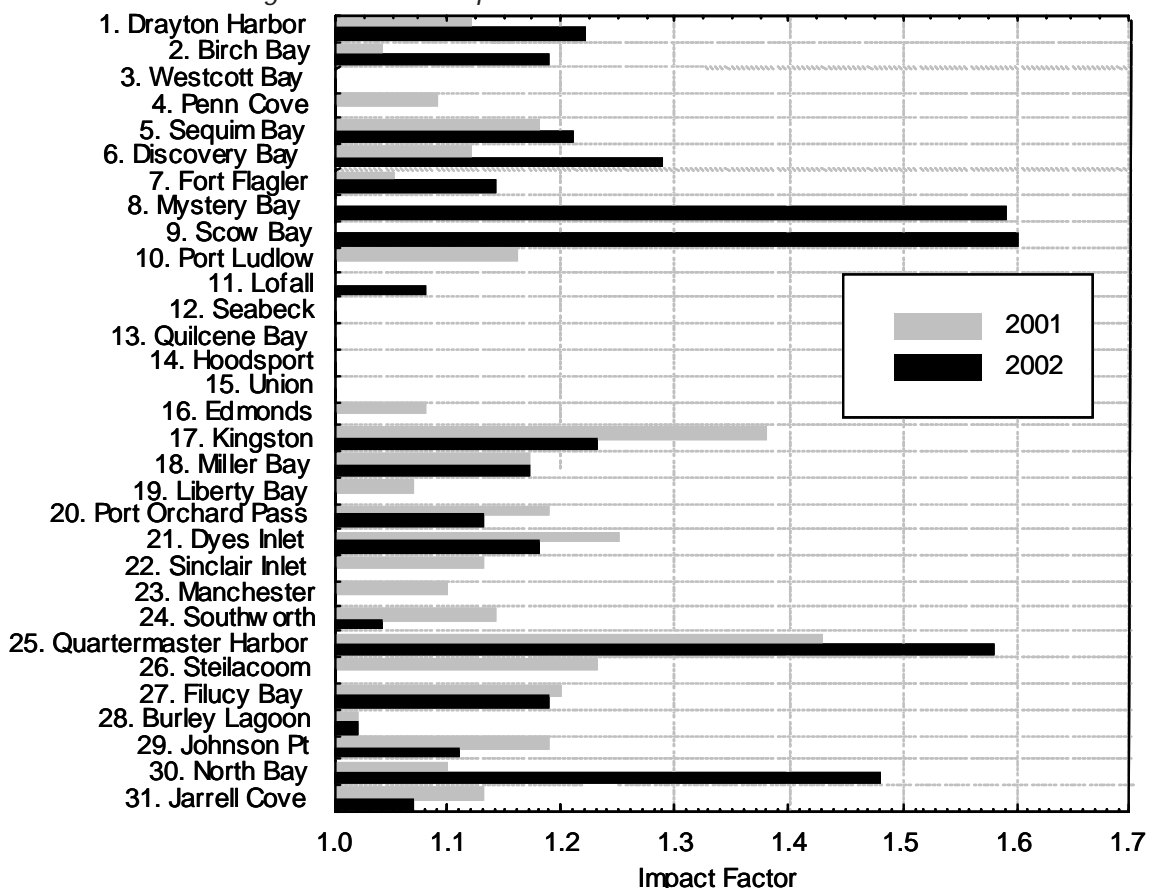
Local health agencies implemented a number of recreational shellfish education and outreach programs through consolidated contracts in 2002. This preventive approach to recreational harvester health promotion is a valuable aspect of the consolidated contracts/ local health partnership. Projects in 2002 included participation in community events and fairs, partnerships with local schools and state parks, educational talks, outreach to high risk harvester populations, newsletter production, and local shellfish telephone hotlines.

High Risk Harvest

High risk harvesters are those harvesting populations who do not understand or have access to health information to assure that the shellfish they harvest are safe to eat. To assess high risk harvest, DOH compares recreational harvester counts calculated by the Department of Fish and Wildlife with pollution data to identify high-risk beaches. Education and outreach efforts are then targeted at those areas to inform the public.

Many of the Asian and Pacific Island (API) communities have long been identified as high risk harvesters due to cultural and language barriers. Focus remains on communicating

Figure 14. PSP Comparisons for Years 2001 and 2002



health risks for recreational harvesters in these communities and assisting with interpretation of health warning and regulatory information.

Beach Classifications

Recreational shellfish beaches are classified by DOH as Unclassified, Approved, Conditional, and Closed. Further analysis of the harvest on Unclassified beaches will help guide classification and education efforts in 2003.

Approved

Approved beaches meet the sanitary standards of water quality and shoreline conditions for shellfish harvest.

Conditional

Beaches are classified Conditional if they reside within a commercial area with that classification. Conditional beaches close and open based on the same criteria as the commercial area, i.e. rainfall, seasonal marina usage, etc.

Closed

Closed beaches are those that either reside within a Prohibited or Restricted commercial area, or otherwise do not meet sanitary standards for water quality and shoreline conditions for shellfish harvesting.

Other reasons that a beach may be closed include the presence of *Vibrio parahaemolyticus*, sewage treatment plant outfalls, and emergency situations. DOH supplies signs reflecting situations that may

affect public health. Figure 15 shows the recreational harvest signs provided by DOH.

Web Site Improvements

In 2002 a new web site was launched that provides information on recreational beach closures. This site works with a mapping tool and shows recreational beach areas that are closed from biotoxins, pollution events, or other health risks. This mapping site's address is www.doh.wa.gov/biotoxinmaps.htm.

For more information on recreational shellfishing contact Wayne Clifford at (360) 236-3307.

Figure 15. Current Recreational Shellfish Harvest Signs

